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(54) **ORGANIC LIGHT EMITTING DISPLAY DEVICE AND TESTING METHOD THEREOF**

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G09G 3/00 (2006.01)
H01L 27/32 (2006.01)

(52) **U.S. Cl.**

CPC ***G09G 3/006*** (2013.01); ***G09G 3/3208*** (2013.01); ***H01L 27/3244*** (2013.01)

(58) **Field of Classification Search**

USPC 345/76, 77, 78, 204, 214, 211, 82–84, 345/55, 36, 45, 90; 324/762.07, 762.01, 324/760.01, 760.02, 403; 315/169.1, 169.3, 315/167, 160, 168, 337, 334, 169.4

See application file for complete search history.

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(57) **ABSTRACT**

An organic light emitting display device and a testing method thereof for detecting a failure occurring in a cutting process of a protective film attached to an upper end of a panel. The organic light emitting display device includes a first substrate on which a pixel unit and a tester are formed. The pixel unit includes a plurality of pixels positioned at intersection portions of scan lines and data lines, and the tester includes a plurality of transistors coupled to the respective data lines so as to supply test signals to the data lines. The transistors are divided into at least two groups, so that transistors of one group are turned on/off by a first test control line, and transistors of another group are turned on/off by a second test control line, the first and second test control lines being disposed on opposite sides of the substrate.

10 Claims, 2 Drawing Sheets

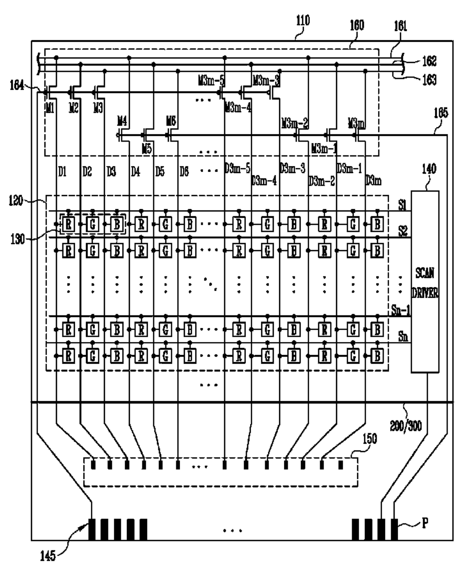


FIG. 1

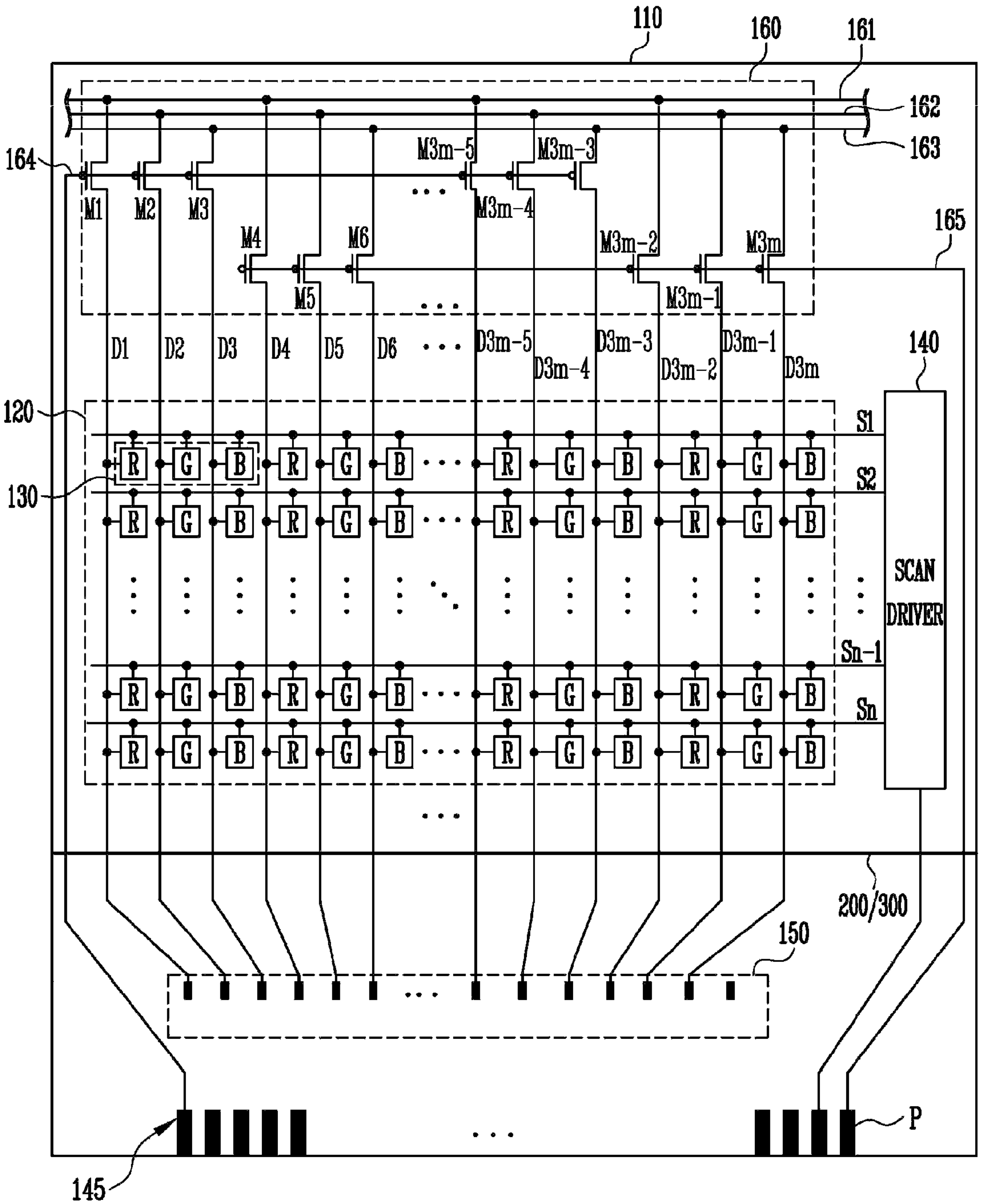

110
160
161
162
163
164
M1
M2
M3
M3m-5
M3m-3
M3m-4
M4
M5
M6
M3m-2
M3m-1
M3m
165
D1
D2
D3
D4
D5
D6
D3m-5
D3m-4
D3m-3
D3m-2
D3m-1
D3m
140
120
130
S1
S2
Sn-1
Sn
SCAN DRIVER
200/300
150
P
145

FIG. 2

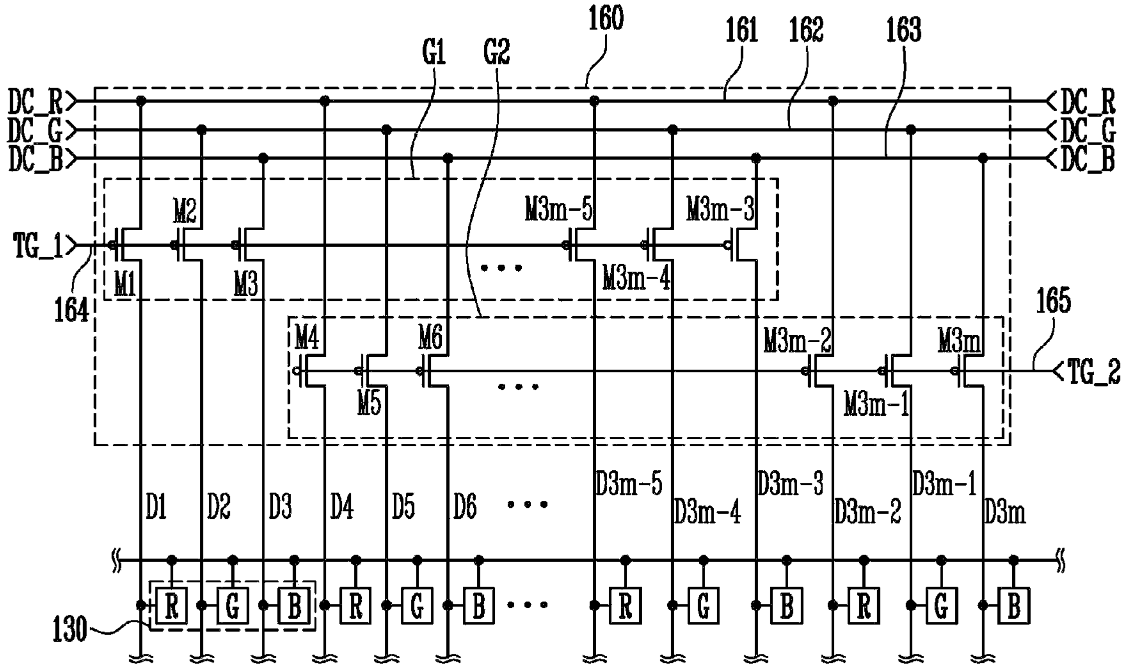
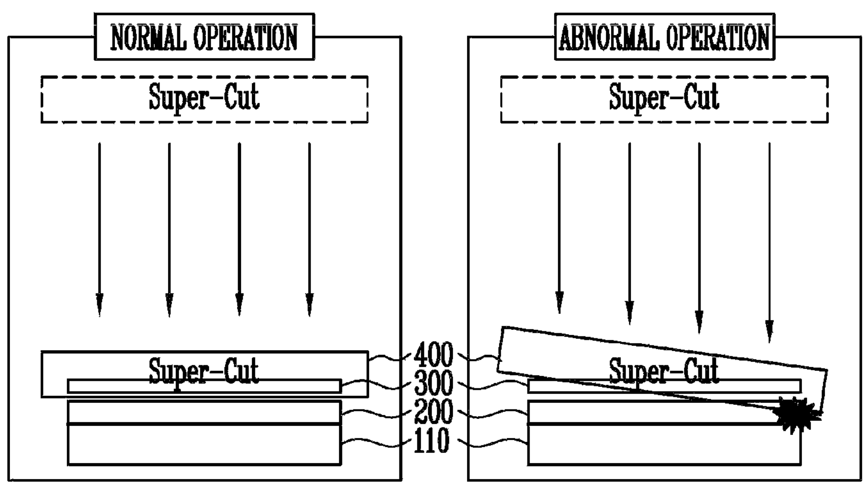

160
161
162
163
G1
G2
DC_R
DC_G
DC_B
TG_1
TG_2
M1
M2
M3
M3m-5
M3m-4
M3m-3
164
165
M4
M5
M6
M3m-2
M3m-1
M3m
D1
D2
D3
D4
D5
D6
D3m-5
D3m-4
D3m-3
D3m-2
D3m-1
D3m
R
G
B
130

FIG. 3


NORMAL OPERATION
ABNORMAL OPERATION
Super-Cut
400
300
200
110

ORGANIC LIGHT EMITTING DISPLAY DEVICE AND TESTING METHOD THEREOF

CLAIM OF PRIORITY

This application makes reference to, incorporates the same herein, and claims all benefits accruing under 35 U.S.C. §119 from an application earlier filed in the Korean Intellectual Property Office on the 22 Oct. 2012 and there duly assigned Serial No. 10-2012-0117537.

BACKGROUND OF THE INVENTION

1. Field of the Invention

An aspect of the present invention relates to an organic light emitting display device and a testing method thereof, and more particularly, to an organic light emitting display device and a testing method thereof, which can detect even a failure occurring in a cutting process of a protective film attached to the upper end of a panel.

2. Description of the Related Art

Recently, there have been developed various types of flat panel display devices capable of reducing the weight and volume of cathode ray tubes, which are disadvantages. The flat panel display devices include, but are not limited to, a liquid crystal display device, a field emission display device, a plasma display panel, an organic light emitting display device.

Among these flat panel display devices, the organic light emitting display device displays images using organic light emitting diodes that emit light through recombination of electrons and holes. The organic light emitting display device has a fast response speed and is driven with low power consumption.

An organic light emitting display device using a self-luminescent element does not use a separate light source such as a backlight, and is advantageous in light weight. Simultaneously, it is suitable to implement a flexible display device.

An organic material that is a key component of the organic light emitting display device is damaged by reacting with water, oxygen, etc., when being exposed to the air. Hence, in the organic light emitting display device, an encapsulation for sealing the upper portion of a panel using glass, film, etc., is essential in the organic light emitting display device.

However, in order to implement a flexible organic light emitting display device, an encapsulation substrate is preferably formed of flexible material, as well as a lower substrate on which pixels are formed. Accordingly, the flexible organic light emitting display device has recently been manufactured by performing a thin film encapsulation using a thin film.

Under the current situation in which a touch method is widely applied as the input method of various types of display devices, the organic material can be more effectively protected from external stimulus by attaching a protective film on the upper portion of a thin-film encapsulated panel. In this case, a cutting process of the protective film should be performed so that a pad portion or IC mounting region of the panel can be exposed, but an element, wire, etc. positioned beneath the protective film may be damaged even in the cutting process of the protective film. Accordingly, it is required to develop an organic light emitting display device and a testing method thereof, which can detect even a failure occurring in the cutting process of the protective film.

SUMMARY OF THE INVENTION

Embodiments provide an organic light emitting display device and a testing method thereof, which can detect even a failure occurring in a cutting process of a protective film attached to the upper end of a panel.

According to an aspect of the present invention, there is provided an organic light emitting display device, including a first substrate on which a pixel unit and a tester are formed, wherein the pixel unit includes a plurality of pixels positioned at intersection portions of scan lines and data lines, and the tester includes a plurality of transistors coupled to the respective data lines so as to supply a test signal to the data lines, and wherein the transistors are divided into at least two groups, so that transistors of one group are turned on/off by a first test control line disposed via a first side of the first substrate, and transistors of another group are turned on/off by a second test control line disposed via a second side opposite to the first side of the first substrate.

The organic light emitting display device may further include an encapsulation substrate that encapsulates one region of the first substrate including at least the pixel unit; and a protective film attached to the upper portion of the encapsulation substrate.

The first substrate, the encapsulation substrate and the protective film may be formed of a flexible material.

A pad portion coupled to an external driving circuit may be provided at one side of the first substrate, and the encapsulation substrate and the protective film may expose the one side of the first substrate including the pad portion.

The pixels may include unit pixels each having a plurality of sub-pixels, and the unit pixels may be divided into first and second pixel groups. Gate electrodes of transistors coupled to the unit pixels of the first pixel group among the plurality of transistors may be coupled to the first test control line, and gate electrodes of transistors coupled to the unit pixels of the second pixel group among the plurality of transistors may be coupled to the second test control line.

The unit pixels of the first pixel group may be set as unit pixels on an odd-numbered column, and the unit pixels of the second pixel group may be set as unit pixels on an even-numbered column.

The first test control line may be coupled to the pad portion of the first substrate via a non-pixel region at the left side of the pixel unit, and the second test control line may be coupled to the pad portion of the first substrate via a non-pixel region at the right side of the pixel unit.

Each transistor may be coupled between any one of a plurality of test signal lines and any one of the data lines.

The test signal lines may include a first test signal line for supplying a red test signal to the data lines, a second test signal line for supplying a green test signal to the data lines, and a third test signal line for supplying a blue test signal to the data lines.

According to an aspect of the present invention, there is provided a testing method for detecting a failure of an organic light emitting display device by supplying a test signal to a plurality of transistors coupled to each data line, wherein the transistors are divided into at least two groups, and transistors of each group are turned on by respectively supplying test control signals to different test control lines disposed via different sides of the organic light emitting display device.

Pixels may be divided into at least two groups, and pixels of each group may emit light by turning on the transistors of the at least two groups at different times.

As described above, according to the present invention, the organic light emitting display device includes a test having a plurality of transistors coupled to each data line so as to supplying a test signal to the data lines. The transistors are divided into at least two groups, and the transistors of each group are turned on/off by first or second test control lines disposed via different sides of the panel. The transistors are driven by respectively supplying first and second test control signals to the first and second test control lines after a cutting process of a protective film, so that it is possible to detect even a failure occurring in the cutting process of the protective film.

BRIEF DESCRIPTION OF THE DRAWINGS

A more complete appreciation of the invention, and many of the attendant advantages thereof, will be readily apparent as the same becomes better understood by reference to the following detailed description when considered in conjunction with the accompanying drawings, in which like reference symbols indicate the same or similar components, wherein:

FIG. **1** is a plan view schematically illustrating a panel of an organic light emitting display device according to an embodiment of the present invention;

FIG. **2** is a main-part enlarged view illustrating a tester shown in FIG. **1** and a testing method using the tester; and

FIG. **3** is a side view schematically illustrating an example in which a failure occurs in a cutting process of a protective film.

DETAILED DESCRIPTION OF THE INVENTION

Hereinafter, certain exemplary embodiments according to the present invention will be described with reference to the accompanying drawings. Here, when a first element is described as being coupled to a second element, the first element may be not only directly coupled to the second element but may also be indirectly coupled to the second element via a third element. Further, some of the elements that are not essential to the complete understanding of the invention are omitted for clarity. Also, like reference numerals refer to like elements throughout.

FIG. **1** is a plan view schematically illustrating a panel of an organic light emitting display device according to an embodiment of the present invention. FIG. **2** is a main-part enlarged view illustrating a tester shown in FIG. **1** and a testing method using the tester.

Referring to FIG. **1**, the panel of the organic light emitting display device includes a first substrate (e.g., a lower substrate) **110** on which a pixel unit **120**, a scan driver **140**, a tester **160**, a pad portion **145**, an IC mounting region **150**, an encapsulation substrate **200** disposed to overlap with one region of the first substrate **110**, and a protective film **300**.

The first substrate **110** is a substrate on which at least the pixel unit **120** is formed, and may be formed of various materials such as glass and film. However, in a case where a flexible display device is implemented, the first substrate **110** may be formed of a flexible material such as a flexible film.

The pixel unit **120** includes a plurality of pixels **130** positioned at intersection portions of scan lines S**1** to Sn and data lines D**1** to D**3***m*. Here, the plurality of pixels **130** may each have a plurality of sub-pixels (e.g., R, G and B sub-pixels). When a scan signal is supplied from the scan driver **140** via scan lines S**1** to Sn, the pixels emit light, corresponding to a test signal or a data signal supplied from the data lines D**1** to D**3***m*.

The scan driver **140** includes shift registers (not shown), which are coupled to the scan lines S**1** to Sn. The scan driver **140** sequentially supplies a scan signal to the scan lines S**1** to Sn.

The tester **160** includes a plurality of transistors M**1** to M**3***m* coupled between one side of each of the data lines D**1** to D**3***m* and any one of a plurality of test signal lines **161**, **162** and **163**. Each of the transistors M**1** to M**3***m* is turned on when a test control signal is supplied to a control electrode, i.e., a gate electrode thereof, so as to supply a test signal from the test signal lines **161**, **162** and **163** to the data lines D**1** to D**3***m*.

In the present invention, the transistors M**1** to M**3***m* are divided into at least two groups, so that the turn-on/off of the transistors of the at least two groups are controlled by different test control lines. For example, the turn-on/off of transistors of one group among the transistors M**1** to M**3***m* may be controlled by a test control signal supplied from a first test control line **164** disposed via a first side (e.g., a non-pixel region at the left side of the pixel unit) of the first substrate **110**, and the turn-on/off of transistors of another group may be controlled by a test control signal supplied from a second test control line **165** disposed via a second side (e.g., a non-pixel region at the right side of the pixel unit) opposite to the first side of the first substrate **110**.

That is, the first and second test control lines **164** and **165** are coupled to the pad portion **145** of the first substrate **110** via different sides of the panel. Each of the first and second test control lines **164** and **165** provides gate electrodes of the transistors M**1** to M**3***m* with a test control signal supplied via a pad coupled thereto.

A configuration of the tester **160** and a testing method of the organic light emitting display device using the tester **160** will be described in detail later.

Meanwhile, the pad portion **145** is formed at one side of the first substrate **110**, and includes a plurality of pads P for coupling the panel to an external driving circuit. A portion of the non-pixel region adjacent to the pad portion **145** may be set as the IC mounting region **150**. The IC mounting region **150** may also include pads for coupling signal lines and/or power lines formed on the first substrate **110** to an IC.

The encapsulation substrate **200** encapsulates one region of the first substrate **110** including the pixel unit **120**. For example, the encapsulation substrate **200** may encapsulate a region including the pixel unit **120**, the scan driver **140** and the tester **160** on the first substrate **110**. However, the encapsulation substrate **200** is not disposed on the pad portion **145** so that one side of the first substrate **110** including the pad portion **145** is exposed. For example, the encapsulation substrate **200** may expose one side of the first substrate **110** including the pad portion **145** and the IC mounting region **150**.

Meanwhile, in order to implement the flexible display device, the encapsulation substrate **200** is preferably formed of a flexible material. To this end, a thin film encapsulation (TFE) is performed using a thin film, so that it is possible to implement the encapsulation substrate **200** that effectively encapsulates the pixel unit **120**.

The protective film **300** is attached to the upper portion of the encapsulation substrate **200** so as to more effectively protect the pixel unit **120** from external stimulus.

The protective film **300** is also disposed to expose the one side of the first substrate **110** including the pad portion **145** and the IC mounting region **150**. In a case where the organic light emitting display device of the present invention is implemented as the flexible display device, the protective film **300** is preferably formed of a flexible material.

In a process of enabling the protective film **300** to expose the one side of the first substrate **110**, one region of the protective film **300** positioned at one upper portion of the first substrate **110** is removed through a cutting process. In this case, a cutting process such as a super-cut process may be performed in order to effectively cut the thin film applied to the flexible display device. The super-cut process has an advantage in that the thin film can be precisely cut using a cutter blade, etc. However, a wire, etc. near a cut region may be damaged by a physical impact that may be applied in the super-cut process.

Accordingly, the present invention provides an organic light emitting display device and a testing method thereof, which can detect even a failure occurring in a cutting process of a protective film. The present invention can be achieved by dividing transistors included in a tester into a plurality of groups and allowing each group to receive a test control signal supplied through different test control lines disposed at different sides of a panel. Hereinafter, the organic light emitting display device and the testing method thereof will be described in detail with reference to FIG. **2**.

Referring to FIG. **2**, each of the transistors M**1** to M**3***m* is coupled between any one of the plurality of test signal lines **161**, **162** and **163** and any one of the data lines D**1** to D**3***m*.

Here, the test control lines **161** and **162** and **163** are used to supply a test signal to the data lines D**1** to D**3***m* via the transistors M**1** to M**3***m*. For example, the test signal lines **161**, **162** and **163** may include a first test signal line **161** for supplying a red test signal DC_R, a second test signal line **162** for supplying a green test signal DC_G and a third test signal line **163** for supplying a blue test signal DC_B. Transistors M**1**, M**4**, . . . , M**3***m*-**5** and M**3***m*-**2** coupled to the first test signal line **161** may be coupled to data lines D**1**, D**4**, . . . , D**3***m*-**5** and D**3***m*-**2** of red sub-pixels R. Transistors M**2**, M**5**, . . . , M**3***m*-**4** and M**3***m*-**1** coupled to the second test signal line **162** may be coupled to data lines D**2**, D**5**, . . . , D**3***m*-**4** and D**3***m*-**1** of green sub-pixels G. Transistors M**3**, M**6**, . . . , M**3***m*-**3** and M**3***m* coupled to the third test signal line **163** may be coupled to data lines D**3**, D**6**, . . . , D**3***m*-**3** and D**3***m* of blue sub-pixels B.

Here, the first to third test signal lines **161**, **162** and **163** may be disposed via at least one side of the panel. For example, the first to third test signal lines **161**, **162** and **163** may be disposed via the left or right side of the panel, or may be disposed at both the sides of the panel. However, the first to third test signal lines **161**, **162** and **163** may be variously modified, and their detailed descriptions will be omitted.

Each of the transistors M**1** to M**3***m* is turned on when a test control signal TG is supplied to the gate electrode thereof, so as to supply a test signal supplied from the test signal lines **161**, **162** and **163** to the data lines D**1** to D**3***m*.

In more detail, the transistors M**1** to M**3***m* are divided into at least two groups, so that the turn-on/off of transistors of each group are controlled by the test control line **164** or **165**. Accordingly, the pixels **130** may be divided into first and second pixel groups. The pixels **130** of each pixel group may be coupled to a transistor group (G**1** or G**2**) controlled by the first or second test control line **164** or **165**. That is, gate electrodes of transistors coupled to the pixels **130** of the first pixel group G**1** among the transistors M**1** to M**3***m* may be coupled to the first test control line **164**, and gate electrodes of transistors coupled to the pixels **130** of the second pixel group G**2** among the transistors M**1** to M**3***m* may be coupled to the second test control line **165**.

For example, when assuming that the pixels **130** of the first pixel group are set as pixels **130** on an odd-numbered column, and the pixels **130** of the second pixel group are set as pixels **130** on an even-numbered column, transistors M**1** to M**3**, M**7** to M**9**, . . . , M**3***m*-**5** to M**3***m*-**3** coupled to the pixels **130** on the odd-numbered column may be classified into the first group G**1** so that the gate electrodes of the transistors are coupled to the first test control line **164**, and transistors M**4** to M**6**, M**10** to M**12**, . . . , M**3***m*-**2** to M**3***m* coupled to the pixels **130** on the even-numbered column may be classified into the second group G**2** so that the gate electrodes of the transistors are coupled to the second test control line **165**.

Here, the first and second test control lines **164** and **165** are disposed via different sides of the panel, which are opposite to each other. For example, the first test control line **164** may be disposed via the left side of the panel so as to be coupled to the pad portion **145**, and the second test control line **165** may be disposed via the right side of the panel so as to be coupled to the pad portion **145**.

By using the tester **160**, it is possible to detect even a failure occurring in the cutting process of the protective film **300**.

Particularly, as a greater impact is applied to the left or right side of the panel due to the inequality of a force that may occur during the cutting process of the protective film **300**, lower wires, etc. may be damaged. In a case where the wires positioned at one side of the panel are damaged, the pixels **130** are turned on/off by respectively supplying first and second test control signals TG_**1** and TG_**2** to the first and second test control lines **164** and **165** in a failure test performed using the tester **160** after the cutting process of the protective film **300**. Accordingly, it is possible to detect the presence of a failure.

More specifically, in a case where the lower wires are damaged as a great impact is applied to the left side of the panel during the cutting process of the protective film **300**, it is highly likely that the first test control line **164** may be damaged. Hence, in a case where the failure test is performed by respectively supplying the first test control signal TG_**1** and the test signals DC_R, DC_G and DC_R to the first test control line **164** and the test signal lines **161**, **162** and **163** after the cutting process of the protective film **300**, the pixels are not normally turned on, so that it is possible to detect the presence of a failure.

In a case where the lower wires are damaged as a great impact is applied to the right side of the panel during the cutting process of the protective film **300**, it is highly likely that the second test control line **165** may be damaged. Hence, in a case where the failure test is performed by respectively supplying the second test control signal TG_**2** and the test signals DC_R, DC_G and DC_R to the second test control line **165** and the test signal lines **161**, **162** and **163** after the cutting process of the protective film **300**, the pixels are not normally turned on, so that it is possible to detect the presence of a failure.

In a case where the wires at both the sides of the panel are all damaged, the pixels are not normally turned on, and hence it is possible to detect the presence of a failure.

That is, according to the present invention, the plurality of the transistors M**1** to M**3***m* coupled to each of the data lines D**1** to D**3***m* are divided into at least two groups G**1** and G**2**, and the transistors of the at least two groups G**1** and G**2** are driven by respectively receiving the first and second test control signals TG_**1** and TG_**2** supplied from the first and second test control lines **164** and **165** disposed via the different sides of the panel. Accordingly, it is possible to detect even a failure occurring at only any one side of the panel in the cutting process of the protective film **300**.

Meanwhile, in a case where the first and second test control signals TG_**1** and TG_**2** are simultaneously supplied, the failure can be detected. Particularly, in a case where the first and second test control signals TG_**1** and TG_**2** are supplied at different times, it is possible to more easily detect the presence of a failure.

The present invention can be particularly usefully applied to the failure test of the flexible display device having the protective film **300**, in which the TFE is performed.

FIG. **3** is a side view schematically illustrating an example in which a failure occurs in a cutting process of a protective film. Particularly, an example is disclosed in which the protective film is cut by a super-cut process.

Referring to FIG. **3**, an encapsulation substrate **200** is disposed on a first substrate **110** so as to encapsulate a pixel unit, etc., and a protective film **300** is disposed on the encapsulation substrate **200**. In this case, the protective film **300** should expose one side of the first substrate **110** including a pad portion (not shown). Therefore, one end of the protective film **300** is removed through the super-cut process in order to expose the one side of the first substrate **110**.

In a case where the cutting process of the protective film **300** is normally performed, an equal force is applied to a cutter blade **400**, and thus the protective film **300** is precisely cut. However, in a case where the cutting process of the protective film **300** is abnormally performed, i.e., in a case where a force is biased to one side of the cutter blade **400**, wires disposed beneath the protective film **300**, positioned at the side where a greater force is applied to the cutter blade **400**, are disconnected, and therefore a failure easily occurs.

Although the cutting process of the protective film **300** is normally performed, the force is applied at the boundary between encapsulation and non-encapsulation regions by the cutter blade **400**. Therefore, it is likely that a defect of the wires may occur in these regions.

Conventionally, it was difficult to detect a failure, and particularly, it was difficult to detect a failure when the failure occurs at one side of the panel. However, according to the present invention, the organic light emitting display device is designed so that the transistors of the tester are divided into at least two groups, and the transistors of each group are turned on/off by the first or second test control lines disposed via different sides of the panel. Accordingly, the transistors are driven by respectively supplying the first and second test control signals to the first and second test control lines after the cutting process of the protective film, so that it is possible to effectively detect even a failure occurring to the cutting process of the protective film.

While the present invention has been described in connection with certain exemplary embodiments, it is to be understood that the invention is not limited to the disclosed embodiments, but, on the contrary, is intended to cover various modifications and equivalent arrangements included within the spirit and scope of the appended claims, and equivalents thereof.

What is claimed is:

1. An organic light emitting display device, comprising: a first substrate on which a pixel unit and a tester are formed, wherein the pixel unit includes a plurality of pixels positioned at intersection portions of scan lines and data lines, the data lines being grouped as odd-numbered column data lines and even-numbered column data lines, and the tester includes a plurality of transistors coupled to the respective data lines so as to supply a test signal to the data lines, and wherein the transistors are divided into a first group connected directly to only the odd-numbered column data lines and a second group connected directly to only the even-numbered column data lines, gate electrodes of the transistors of the first group are turned being commonly connected to a first test control line, and gate electrodes of the transistors of the second group being commonly connected to a second test control line.

2. The organic light emitting display device according to claim **1**, further comprising:

an encapsulation substrate that encapsulates one region of the first substrate including at least the pixel unit; and

a protective film attached to an upper portion of the encapsulation substrate.

3. The organic light emitting display device according to claim **1**, wherein the pixels each include a plurality of sub-pixels, the sub-pixels including red, green and blue sub-pixels, and the test signal including red, green and blue test signals.

4. The organic light emitting display device according to claim **2**, wherein the first substrate, the encapsulation substrate and the protective film are formed of a flexible material.

5. The organic light emitting display device according to claim **2**, further comprising a pad portion coupled to an external driving circuit, the pad portion being provided at one side of the first substrate, and the encapsulation substrate and the protective film expose the one side of the first substrate including the pad portion.

6. The organic light emitting display device according to claim **5**, wherein the first test control line is coupled from a first pad of the pad portion via a non-pixel region at a left side of the pixel unit to the transistors of the first group, and the second test control line is coupled from a second pad of the pad portion via a non-pixel region at a right side of the pixel unit to the transistors of the second group, the pixel unit being disposed between the tester and the pad portion.

7. The organic light emitting display device according to claim **6**, wherein the first pad is disposed at a first distal end of the pad portion and the second pad is disposed at a second distal end of the pad portion.

8. The organic light emitting display device according to claim **7**, further comprising an integrated circuit mounting region disposed the exposed one side of the first substrate.

9. A testing method for detecting a failure of an organic light emitting display device having a pixel unit including a plurality of pixels positioned at intersection portions of scan lines and data lines, the data lines being grouped as odd-numbered column data lines and even-numbered column data lines, the method comprising:

supplying a first test control signal to a first group of transistors of a test unit;

supplying a second test control signal to a second group of transistors of a test unit;

the first group of transistors being connected directly to only the odd-numbered column data lines, the pixels of the odd-numbered column data lines being turned on in a first time period in response to test signals supplied by the first group of transistors in response to the first test control signal; and

the second group of transistors being connected directly to only the even-numbered column data lines, the pixels of the even-numbered column data lines being turned on in a second time period in response to test signals supplied by the second group of transistors in response to the second test control signal, the second time period different from the first time period.

10. The method as set forth in claim **9**, wherein the pixels each include a plurality of sub-pixels, the sub-pixels including red, green and blue sub-pixels, and the test signals including red, green and blue test signals, the method further comprising:

turning on the red sub-pixels in response to the red test signals;

turning on the green sub-pixels in response to the green test signals; and

turning on the blue sub-pixels in response to the blue test signals.

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